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Foundation of a Pavement Management System for the City of Baton Rouge, Louisiana

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***Abstract*— The need for a large city based Pavement Management System (PMS) is becoming more of a necessity as local agencies struggle to keep up with the growing demand of rehabilitating the roadway infrastructure in their jurisdiction. The PMS system must be specialized to meet the governing agencies needs. It is with this in mind that this study was conducted.**

This study provides the local governing agency, the City of Baton Rouge, LA, with the foundation necessary for forming their PMS. Because of the lack of historical data at the beginning of the PMS life, it is imperative that the city use the Louisiana Department of Transportation and Development (LADOTD) pavement family curves, distress triggers, maintenance strategies, and prioritization methods until enough data is gathered to formulate these parameters privately. This study evaluates fifteen state owned and maintained corridors within the city of Baton Rouge, LA for the purpose of determining the effectiveness of the proposes PMS foundation. It also provides detailed methodology regarding database development, data analysis/work program development, and feedback evaluation.

Keywords-Pavement Management System, PMS

I. INTRODUCTION AND BACKGROUND

In the past pavement maintenance techniques were dictated solely by the pavement engineer's experience with little attention to life-cycle costs or prioritization of network needs. [1]

At the close of the 1960s, highway agencies realized there was an inherent need to manage the investment made in the national highway network. Pavement Management Systems (PMSs) were devised as a way to move from the current "Design-Build" ideology to the "Maintenance-and-Rehabilitation theory. [2]

Since the early 1970s PMSs have continually evolved in their scope, methodology, and application. The early methods consisted of ranking the pavements based on the sections current pavement condition and traffic needs. [2] These were basic methods that only accounted for funding in that year, other wised termed single year prioritization. As time progressed, pavement agencies have realized the importance of a multiyear prioritization method that accounts for overall network goals and budgets.

Throughout the years, many studies have been conducted to determine whether or not PMSs are viable methods to achieve this goal. The consensus of these studies is that the PMSs should be tailored to each agency's specific needs. Current PMSs are business tools whose goal is providing the information necessary to make cost-effective decisions on the pavements in their jurisdiction, keeping in mind the needs of the entire pavement network. [3].

Some researcher described the PMS as the approach to optimize the implementation of highway construction and maintenance resources. Thus optimizing current pavement condition assessment application will be the first and primly task of efficient pavement management system. [4]

The Federal Highway Administration (FHWA) defines PMS as *"Set of tools or methods that can assist decision makers in finding cost-effective strategies for providing and maintaining pavements in serviceable condition"*.

In order to accurately represent this definition, the PMS must answer the following questions [5]:

What is the most cost-effective treatment?

Where and when to apply the treatments?

Since PMS data always have spatial characteristics, it is only natural to store this data using a spatially consistent referencing system such as a Geographic Information System (GIS). [6, 7, 8, 9]

The Federal Interagency Coordinating Committee defines GIS as *"A system of computer hardware, software and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems"*. [5]

The application of GIS in PMSs is becoming more widely used at the state level, but still may be too advanced for the personnel at a more local level such as the city or county.

An effective PMS also uses engineering economics to better predict the cost of rehabilitation over the specified analysis period. Since the main objective of the PMS is to prioritize the maintenance needs of a network in the most cost-effective way, cost information is used to carry out the following tasks:

- Identify the cost of each maintenance and rehabilitation method,
- Prioritize network needs based on Incremental Benefit Cost (IBC) and Marginal Cost Effectiveness (MCE),
- Determine the activities that can be carried out for a given fiscal period.
- Develop a list of recommendations, treatment methods, and costs associated with the proposed work program. [10]

Beginning in the mid 1980s, PMSs started to become increasing popular in state and local agencies. Many local agencies such as city and county governments have begun to realize the benefits of a "decision-support" process used to help find cost-effective ways to manage their pavement network and keep their roads in serviceable condition. [5]

The PMS for the state of Louisiana began in the early1970s. The method of data collection has advanced from windshield surveys to video logs in the early 1990s to the use of an Automatic Road Analyzer (ARAN) van in the mid 1990s. Currently the LADOTD collects roughness (IRI), rut, cracking, faulting, and patching data every two years on its network of roads. The LADOTD uses dTIMS software to analyze and model pavement condition data. The condition is reported on an index scale from 0-100 (100 being perfect). [3]

The LADOTD has made PMS data available to all the districts; however the users are reluctant to utilize the databases for various reasons such as system Complexity, untimely Data Posting, employed data aggregation type, lack of training/communication, inadequate Report Generation, and lack of clarity about benefits of system use. [3]

Due to these problems faced at the state level, it is logical that the city attempts to minimize these same issues in its PMS.

The primary requirement for a city or county PMS is, *"the system should be simple to maintain and operate."*[11]

A review of the state of Louisiana's PMS states that,

"Poor highway pavements contribute to negative image of Louisiana as well as leading to increased vehicle repair cost, increased freight damage, and a general decrease in highway safety. A well-maintained highway system is critical to the state's economy including tourism and the transport of products to market." [0]

The main objective of this research is to develop the foundation of a city wide PMS for the city of Baton Rouge, Louisiana. To achieve this objective, the following activities were carried in accordance with the problem statement:

- Select a minimum of fifteen different sections in the city network (at least five flexible and five rigid sections). For each section, determine and locate the number of sampling units. Conduct the visual survey for these sampling units and determine the PCI (Pavement Condition Index) for the sections.
- Extract the performance measures for these sections from the Louisiana PMS.
- Recommend a procedure for implementation of the data from the Louisiana PMS into the city management activities.

For the fifteen sections, predict performance trends, maintenance needs, and prioritize the recommended activities based on life-cycle cost analysis and other tools (typical cost data may be assumed from the LADOTD bid items available on its website).

- Due to lack of proper resources to attain geographic references, several mapping and satellite imagery tools were utilized to attain inventory data to match that of the LADOTD database.

Monismith et al. [11] identifies the items necessary for taking into consideration when developing a PMS as:

"Section Identification, Pavement Condition Surveys,Other Files, Maintenance and Rehabilitation Alternatives, Performance Prediction, Network Programming,Optimization, Data Management and Reports"

This study focused on many of these points with emphasis on what is needed for the city of Baton Rouge, Louisiana. The research was divided into three modules, listed below:

- Data Collection,
- Data Analysis, and
- Costs Optimization.

II. DATA COLLECTION MODULE

The Data Collection module details the processes of section identification, data collection, and data base management.

A. Section Identification

Section identification is the first step in data collection. The roadway sections are the linking factor between the various types of data required in the PMS database. The sections should be consistent in surface type, structural capacity, and traffic volume. Some city agencies designate sections on a "block-by-block" basis, while others may have sections of several miles in length. [11] In either case the sections should be consistent based on type and classification. Inventory data from the LADOTD in addition to DOTD Roadware maps were used to select optimum sections for this study. Figure 1 shows one of the Roadware maps used in this study.

It was necessary to select pavement sections which have data in order to form the comparison needed to support the viability of a local PMS. For this reason state highways were the focus of the analysis of this study. A total of fifteen sections were selected, ten sections were compared to LADOTD data while the remaining five were evaluated for consistency purposes. The selected sections are shown in Table 1.

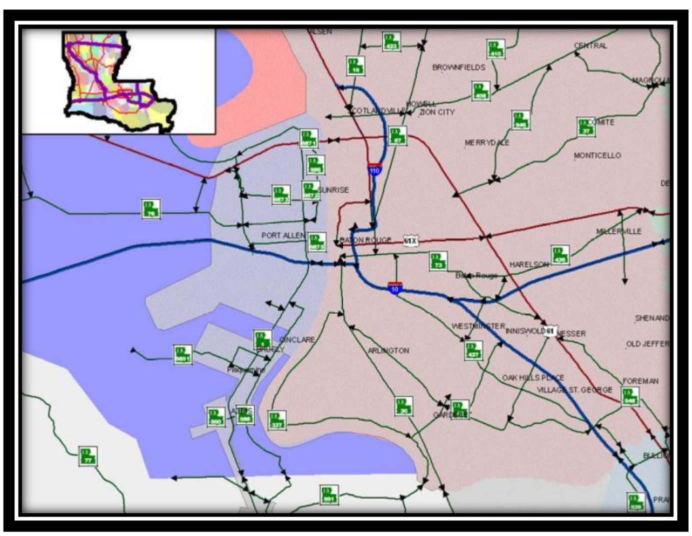

Figure 1: LADOTD Roadware Map

After the sections have been identified, the sections were divided into subsections called sample units. Sample units are defined as a, "*portion of a pavement section designated only for the purpose of pavement inspection*." [11] The results of the sample determination analysis are shown in Table 2.

A "systematic random" approach was recommended for the evaluation of the sample units in the section. This method spaces the samples to be inspected throughout the section equally and uses a random starting point.

Upon completion of determining which sample units are to be surveyed, the process of conducting the pavement condition surveys in order to determine the pavement condition of the sections begun.

B. Pavement Condition Surveys

Pavement condition is highly dependent on the number and severity of distresses observed in the pavement structure. Ride quality and skid resistance are important indicators of pavement performance and are significantly impacted by surface distresses. [11] The Army Corps of Engineers developed a parameter for evaluating pavement condition known as the Pavement Condition Index (PCI). The PCI is a numerical index, ranging from 0 to 100 (100 being perfect) and is calculated based on the results of visual fields surveys. These surveys collect data in relation to distress type, quantity, and severity. The data requirements vary based on pavement surface type, but the methods are similar: determine distress, use graphical distress curves to quantify distresses, and calculate PCI.

Visual surveys were conducted and compared to the LADOTD data. The LADOTD uses sophisticated data collection equipment known as an Automatic Road Analyzer (ARAN) Van. This system collects distress data in a continuous stream and is reported every tenth (1/10) of a mile. Additionally, the LADOTD PMS provide condition data in terms of Present Serviceability Index (PSI) which is on a scale of 0 – 5; because of this, the LADOTD PCI was estimated by multiplying the PSI by a multiplication factor depending on the surface type. According to the current AASHTO design guide, the PSI of newly constructed flexible pavement is 4.2 and the PSI for newly constructed rigid pavement is 4.5. Considering these limits of the scales the multiplication factors must be adjusted on a scale from 0-84 (84 being perfect) for flexible pavement, and 0-90 (90 being perfect) for rigid pavements. The LADOTD PSI was then multiplied by a factor of 25, approximately (100/4.2) for the flexible pavement sections and 23, approximately (100/4.5), for the rigid pavement sections in order to equate the scales of these parameters for comparison. Once the visual survey was completed, the PCI for each sample unit was determined. The results of theses PCI calculations are shown in Table 3 and Table 4 for flexible and rigid pavement respectively.

Table 1: PAVEMENT CONTROL SECTIONS

Control Sections												
Parish: BR District: 61												
Section ID	State Route	Street ID	Begin	End	Pavement Type	Control Section	Length (mile)	Lanes	Begin LogMl	End LogMl	PSI	IRI
01	30	St.Philip	Gov. St (73)	I-10 OP	Flexible	414-01	0.29	6	0.00	0.24	2.4	175
02	30	Nicholson	Stadium (327)	Burbank	Rigid	414-01	0.12	4	2.22	2.30	2.2	196
03	30	Nicholson	Burbank	Bob Petit	Flexible	414-01	0.63	2	2.87	3.31	3.6	78
04	30	Nicholson	Bob Petit	Brightside	Flexible	414-01	0.66	2	3.31	4.37	3.6	78
05	327	Stadium	River Road (327)	IC Railroad	Rigid	817-16	0.45	4	9.36	10.32	2.9	131
06	327	Stadium	IC Railroad	Nicholson (30)	Rigid	817-16	0.12	4	10.32	10.77	2.4	181
07	327	River Road	Stadium (327)	Gourrier	Flexible	817-16	0.40	2	10.77	10.89	2.4	181
08	327-S	Gardere	River Road (327)	Nicholson (30)	Flexible	257-03	0.38	2	2.04	2.42	3.2	111
09	42	Burbank	Nicholson (30)	E.Boyd	Rigid	257-04	0.47	4	4.77	4.08	2.2	1.96
10	42	Burbank	E. Boyd	Begin Median	Rigid	257-04	0.22	4	4.77	4.08	2.2	1.96
11	1068	Drusilla	Jefferson (73)	North I-12 off Ramp	Rigid	817-32	0.15	4	NA			
12	73	Jefferson	Drusilla (1068)	Essen(3064)	Rigid	077-05	0.45	5				
13	30	Nicholson	Brightside	Ben Hur	Flexible	414-01	0.28	2				
14	30	Nicholson	Ben Hur	Gardere	Flexible	414-01	2.56	2				
15	30	Nicholson	Gardere	Bluebonnet	Flexible	414-01	0.71	2				

Table 2: SAMPLE UNIT DETERMINATION RESULTS

Sample Unit Determination								
Parish: BR District: 61								
Section ID	**Length (ft)**	**Lanes**	**Area (ft^2)**	**Pavement Type**	**No. of Sample Units, N**	**Min. No. of Sample Units, n**	**Interval, i**	**Random Start, S**
01	861	1	154.98	Flexible	6	5	1	1
02	520	1	6240	Rigid	2	2	1	1
03	2400	1	28800	Flexible	16	8	2	2
04	3484.8	1	41817.6	Flexible	23	9	2	1
05	2376	1	28512	Rigid	6	5	1	1
06	680	1	8160	Rigid	2	2	1	1
07	2100	1	25200	Flexible	14	7	2	1
08	1800	1	21600	Flexible	9	6	1	1
09	2800	1	33600	Rigid	7	6	1	1
10	1161.6	1	13939.2	Rigid	4	4	1	1
11	792	1	9504	Rigid	2	2	1	1
12	2376	1	28512	Rigid	8	7	1	1
13	1478.4	1	17740.8	Flexible	10	6	1	1
14	13516,8	1	162201.6	Flexible	75	14	5	5
15	3749.8	1	44985.6	Flexible	25	10	2	2

Table 3: FLEXIBLE PAVEMENT PCI RESULTS

Section ID	Sample Unit No.															Section PCI	PSI	Adj PSI
	PCI on each Section																	
1	1	2	3	4	5	6										82.1	2.4	60
	85	85	53	99	87	84												
3	2	4	6	8	19	12	14	16								95.0	3.6	90
	85	83	100	100	100	100	100	92										
4	1	3	5	7	9	11	13	15	17	19	21	23				91.0	3.6	90
	78	100	100	85	100	100	100	99	100	95	76	63						
7	1	3	5	7	9	11	13									62.9	2.4	60
	55	71	59	47	54	74	80											
8	1	2	3	4	5	6	7	8	9							80.7	3.2	80
	100	90	93	82	88	84	69	86	34									
13	1	2	3	4	5	6	7	8	9	10						94.2	-	-
	87	83	90	100	100	100	98	90	97	98								
14	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	97.0	-	-
	100	100	98	100	100	100	79	100	100	80	100	97	100	100	100			
15	2	4	6	8	10	12	14	16	18	20	22	24				91.4	-	-
	93	93	100	100	39	84	100	100	100	94	100	94						

Table 4: RIGID PAVEMENT PCI RESULTS

Section ID	Sample Unit No.								Section PCI	PSI	Adj PSI
	PCI on each Section										
2	1	2							72.0	2.2	50.6
	72	72									
5	1	2	3	4	5	6			79.5	2.9	66.7
	87	90	78	58	82	82					
6	1	2							82.5	2.4	55.2
	81	84									
9	`	2	3	4	5	6	7		84.0	2.2	50.6
	84	84	87	72	90	90	81				
10	1	2	3	4					76.5	2.2	50.6
	70	72	76	88							
11	1	2							76.0	-	-
	77	75									
12	1	2	3	4	5	6	7	8	80.7	-	-
	82	80	82	84	54	87	88	88			

The PCI values calculated for the HMA sections show a good correlation with respect to LADOTD PSI values, when outliers were removed. However, the PCI values calculated for the PCC sections did not show a valid correlation to the LADOTD PSI data. This is most likely due to the consideration of only the "truck lane" during the field survey. In most cases the flexible pavement sections were two lane roads, where as the rigid pavement sections were typically four lanes. The fact that the HMA "outlier" was a six lane section supports this logic. Also, the LADOTD has much more sophisticated data acquisition techniques, which would better determine distress severity and quantity.
Figure 2 shows the correlation between the PCI values calculated with the database PSI.

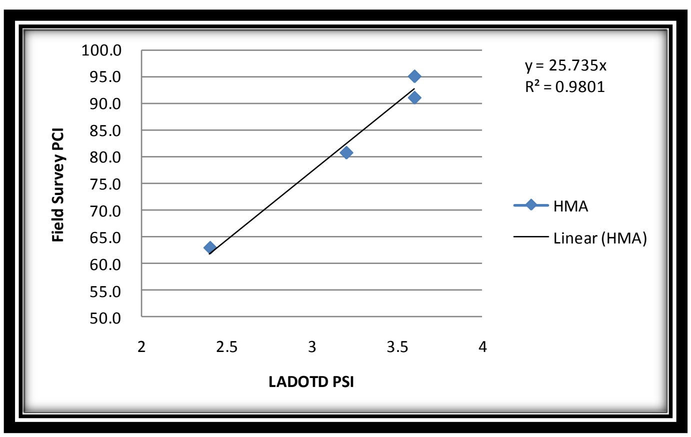

Figure 2: Calculated HMA PCI vs. LADOTD PSI

C. Data Management

As stated previously, the database is the foundation for the entire PMS. The quality of the database directly affects the effectiveness of the PMS. Databases for large networks require computer programs to store and display the large variety of data contained within them. For this reason Microsoft Access was used to form the database for this research. The database should contain information regarding: inventory, distress (HMA, PCC), traffic, condition and maintenance strategies and costs [1]

Table 5 through 10 shows the components of the database used in this study.

Table 5: INVENTORY DATA

Section ID		
Route ID	End Log Mile	Pavement Classification
Street Name	Section Length	Number of Lanes
Begin Log Mile	Pavement Type	Lane Width

Table 6: HMA DISTRESS DATA

Section ID			
Sample Unit	corrugation	Long & Trans Cracking	Rutting
Alligator Cracking	Depression	Patching & Unit Cut	Shoving
Bleeding	Edge Cracking	Polished Aggregate	Slippage Cracking
Block Cracking	Jt Reflective Cracking	Potholes	Swell
Bumps and Sags	Lane/Shoulder Drop Off	Railroad Crossing	Weathering/Raveling

Table 7: PCC DISTRESS DATA

Section ID			
Sample Unit	Faulting	Patching (small)	Scaling
Blowup/ Buckling	Joint Seal	Polished Aggregate	Shrinkage
Corner Break	Lane/ Shoulder Drop Off	Popout	Spalling Corner
Divided Slab	Linear Cracking	Punchout	Spalling Joint
Durability Cracking	Patching (large)	Railroad Crossing	

Table 8: TRAFFIC DATA

Section ID	
Route ID	ESAL
AADT	Truck
	Growth Rate (k)

Table 9: CON DITION DATA

Section ID	
Route ID	IRI
PCI	PSI

Table 10: MAINTENANCE STRATEGY AND COST

Section ID	
PCI	Section Length
Maintenance Strategy	Total Cost
Unit Cost	

D. Prediction Models

It is extremely important for the governing transportation agency to accurately predict the future performance of the pavements in their network. In a PMS, the prediction models drive decision making process with respect to maintenance strategy and scheduling. [1] The models are also used to identify the most cost effective methods of maintenance and rehabilitation. [2].

Performance models are often divided into two categories: deterministic and probabilistic. The deterministic model's output is a single datum, while the probabilistic model's output is a range of data to account for variability of input data. The probabilistic models are often used in the state and national level PMSs; while the deterministic models are used for more localized project level PMSs. Examples of the deterministic methods are linear and non-linear regressions. Probabilistic models include Markovian and Semi-Markovian methods.

E. Performance Prediction Curves

The pavement deterioration curves are developed with age (time) on the x-axis and distress index (PCI) on the y-axis.

It is not feasible or cost effective to develop a pavement deterioration curve for each section in the pavement network. For this reason, deterioration curve may be grouped into families. Each section within a pavement family should have similar deterioration characteristics. Families are often grouped by: rank, pavement type, and date of construction.

The method of modeling used in this research was deterministic regression modeling. This method was used based on the initial constraint that a localized PMS should be simple to maintain and operate. [11] Upon completion of developing these curves it was necessary to evaluate important statistical parameters such as coefficient of determination (R^2) and root-mean square error (RMSE). A model can have a high R^2 and still be an inadequate model. For this reason RMSE is used to evaluate the difference between the predicted data and the observed data.

The reality that LADOTD has been recording data for only seven years, combined with the fact that they have been maintaining the roads on which the data is recorded makes formulating prediction curves very difficult. In each of the 10 sections compared with LADOTD data the curves of condition vs. time yield nearly horizontal lines making it difficult to develop a prediction curve. For this reason, the LADOTD pavement family curves should be used to evaluate the rigid and flexible pavements until the city can collect enough data to develop their own curves. A pavement family curve for flexible pavement is shown in Figure 3. The curve represents a non-linear regression analysis of the states PMS data.

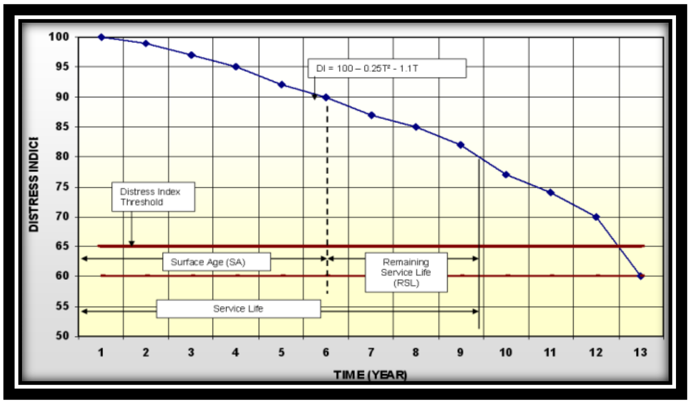

Figure 3: LADOTD Flexible Pavement Deterioration Curve

III. DATA ANALYSIS MODULE

The Data Analysis module covers the steps necessary for determining the proper maintenance and rehabilitation strategies based on the condition of the sections.

A. Maintenance and Rehabilitation Alternatives and Cost

After the pavement deterioration curves were developed, the agency should evaluate the curves and determine "trigger values" that identify the maintenance procedure necessary to maintain the pavement in serviceable condition. The maintenance procedures should address the immediate as well as the long term needs of the pavement.

Maintenance and rehabilitation costs are an important component of the PMS database. These costs are used to objectively evaluate the different maintenance strategies based on the needs of the section. For the purpose of this study the maintenance strategy cost was assumed based on the LADOTD weighted average bid costs. These bid cost were used in the Life-cycle cost analysis of this research.

The maintenance strategies and costs decision trees were used to evaluate the maintenance strategies. The strategies were based on the average condition of the pavements being evaluated. As the city develops a more detailed database, the strategies may be based on the factors contributing to the pavement condition. The LADOTD has performance curves based on the distress indices rather than the composite index, which is only possible with larger databases.
Figure 4 and 5 shows the decision tree used to determine the maintenance strategies for the flexible pavement sections and the rigid pavement sections respectively.

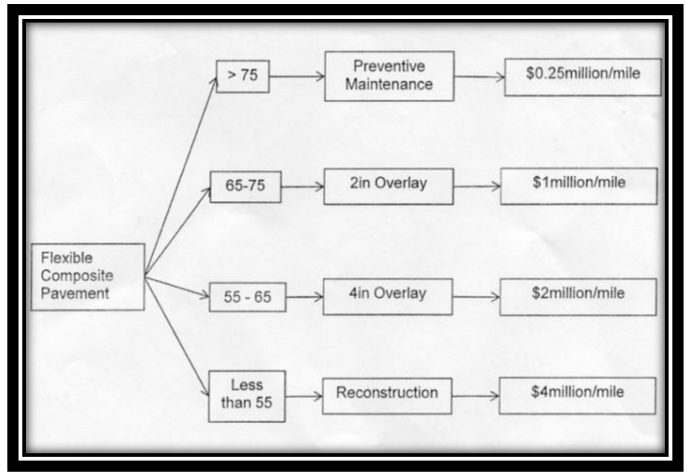

Figure 4: Flexible Pavement Maintenance Decision Tree

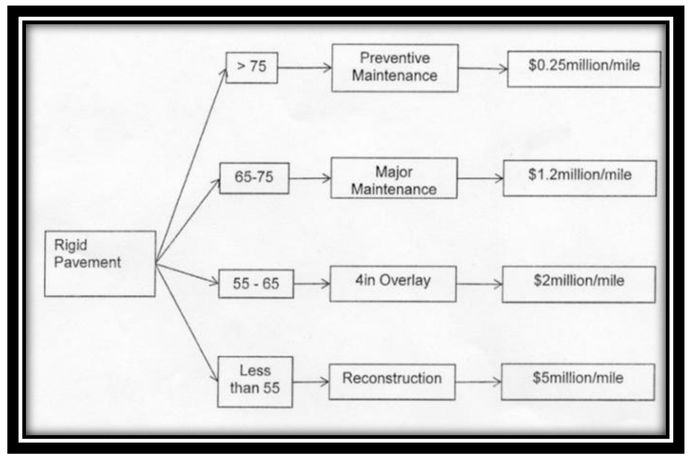

Figure 5: Rigid Pavement Maintenance Decision Tree

I. COST OPTIMIZATION MODULE

Finally, the Cost Optimization module maps out the methods used to determine the most cost-effective means of performing the maintenance and rehabilitation activities indentified in the second module. The methods described in the third module have undergone significant evolution since the inception of PMSs. Kulkami and Miller [2] state, "*Early systems used only initial construction costs of rehabilitation actions. Candidate projects were ranked on the basis of some simple measure (such as weighted index of current distresses), and projects were selected by moving through this list until the entire construction budget was used. User costs were not analyzed, and life-cycle costs were not calculated*." These methods did not meet the optimization needs of the agencies forcing a shift in the ideology surrounding the economic component of the PMS. Agencies are now using Life-Cycle Cost Analysis (LCCA) as an objective means of comparing design and rehabilitation strategies. [10].

A. Application of Life-Cycle Cost Analysis

Life-cycle cost analysis (LCCA) is an objective way of comparing maintenance strategies for the purpose of determining the most cost-effective approach. "In practice, a LCCA is a procedure most often used as a project-level design activity providing a means for incorporating consideration of both engineering and economic factors into the selection of a design strategy. It allows transportation agencies to better estimate the costs involved in pavement maintenance and rehabilitation programs by taking into account the economic assessment of different rehabilitation alternative on the basis of all significant cost expected over the life of each alternative in equivalent dollars." [10] Also at the project level, the agency may use LCCA to determine whether or not it can afford the initial and maintenance cost for a given maintenance strategy. Because different maintenance strategies will deteriorate at different rates, it is important to use fundamental concepts of engineering economics to evaluate the cost of each strategy in equivalent dollars. [10]

Costs to be considered when conducting LCCA include: initial costs, maintenance costs, user costs, and salvage costs. Two important economic factors to indentify when conducting LCCA are Marginal Cost Effectiveness (MCE) and Incremental Benefit Cost (IBC).

The cost given in the decision trees shown previously was assumed to be the present values including; initial costs, maintenance costs, user costs, other costs, and salvage costs of the corresponding maintenance treatment. Because different maintenance strategies are effective for different lengths of time, it is vital to determine the entire cost in equivalent dollars before comparing strategies.

1) Budgets

The budgets are important needs to indentify when developing a PMS at any level. The budgets are used to determine the type and schedule of the management strategies and are the limiting factor in determining which sections of roadway to rehabilitate.

B. Prioritization and Optimization

There are several methods of prioritization that may be considered when developing a PMS: ranking, prioritization, and optimization are common techniques used to determine which rehabilitation strategies to use.

Ranking, also termed single year prioritization is the simplest approach. The sections are arranged in descending order based on their condition. A maintenance strategy and corresponding cost is selected based on the condition of the section. Then the cost totals for each section are summed starting with the highest rank until the available budget is depleted. Weighting factors are often applied to adjust the condition rating of the pavements based on the traffic requirements of the pavement.

Multiyear prioritization (MYP) uses the parameters developed by LCCA to determine the most cost effective strategies over a given analysis period. The components necessary for MYP include: accurate strategy benefits, accurate strategy costs, and the ratio between benefit and cost.

Optimization uses sophisticated mathematical modeling techniques to determine agency goals. Most agencies are reluctant to use optimization because of its complexity and perceived loss of control by the decision makers. The process requires trained personnel with backgrounds in mathematics, statistics, and operations as well as sophisticated computers to run the software.

For the purpose of this study ranking was considered based on its ability to be easily understood. Also the state of Louisiana uses a ranking system in its PMS; therefore the city's PMS should not be more complicated than that of the state.

1) Ranking

The sections were ranked from worst condition to best condition. Because the traffic class of the sections were similar, it was not necessary to consider traffic weighting factors. It is beneficial to consider traffic loading when ranking the sections in order to determine the sections which will yield the greatest benefit through rehabilitation. A budget of two million dollars ($2,000,000) was assumed. The results of the prioritization of the network are shown below in Table 11. The shaded region represents the sections to be addressed in the upcoming year.

II. RECOMMENDATIONS

"PMSs have proved to be effective tools for maximizing the use of the limited resources available for pavement maintenance and rehabilitation." [2] A foundation of a large city PMS for the City of Baton Rouge, LA was developed with the following recommendation:

- Data Acquisition
  - Outsource the data collection to a private consultant as the LADOTD does require that the consultant use the Automatic Road Analyzer (ARAN) van and collect distress data as discussed in this research.
  - The ARAN data for a local government should be collected every 2-3 years. [11]

- Database Management
  - A computer based data storage and organizing system, such as Microsoft Access, should be used to house the data collected by the ARAN survey.
  - The database should include, but is not limited to, information regarding, inventory, distress, traffic, condition, and maintenance strategies and costs.
  - The database should also include information regarding construction date and material characteristics of the pavement.

Table 11: SINGLE YEAR PRIORTIZATION

Single Year Prioritization							
Control Section	**Section ID**	**PCI**	**Maintenance Strategy**	**Unit Cost ($/mile)**	**Length**	**Total Cost ($)**	**Pavement Type**
817-16	7	62.9	4 in Overlay	2000000	0.69	1,380,000	Flexible
414-01	2	72	Major Maintenance	1200000	0.12	144,000	Rigid
817-32	11	76	Preventive Maintenance	250000	0.15	37,500	Rigid
257-04	10	76.5	Preventive Maintenance	250000	0.22	55,000	Rigid
817-16	5	79.5	Preventive Maintenance	250000	0.45	112,000	Rigid
257-03	8	80.7	Preventive Maintenance	250000	0.38	95,000	Flexible
077-05	12	80.7	Preventive Maintenance	250000	0.45	112,000	Rigid
414-01	1	82.1	Preventive Maintenance	250000	0.29	72,500	Flexible
817-16	6	82.5	Preventive Maintenance	250000	0.12	30,000	Rigid
257-04	9	84	Preventive Maintenance	250000	0.47	117,500	Rigid
414-01	4	91	Preventive Maintenance	250000	0.66	165,000	Flexible
414-01	15	91.4	Preventive Maintenance	250000	0.71	177,500	Flexible
414-01	13	94.2	Preventive Maintenance	250000	0.28	70,000	Flexible
414-01	3	95	Preventive Maintenance	250000	0.63	157,500	Flexible
414-01	14	97	Preventive Maintenance	250000	2.56	640,000	Flexible
						Total Cost = 3,366,500	

- Analysis
  - Methods similar to that of the LADOTD should be used in calculating the condition of the pavements in the network. The LADOTD used IRI and PSI as their main indicators of pavement condition. These parameters are easily calculated from the ARAN data.
  - Additionally, the LADOTD pavement family curves should be used to predict the future condition of the pavements until enough data can be gathered to formulate specific curves to meet the agency's needs.
  - The city should also use the LADOTD trigger values and maintenance strategies until enough data is gathered to form more specific conclusion.

- Prioritization
  - The method of prioritization should be similar and no more complicated than that of the LADOTD.
  - Single Year Prioritization should be used, while considering the life cycle costs of the possible maintenance strategies.
  - Decisions should be made with budget considerations in mind.

III. CONCLUSIONS

Pavement maintenance programs have evolved considerably; from engineering judgment and recommendations used prior to the 1960s to the systematic decision processes used today. Throughout their evolution PMSs have focused on three main points:

- Determining the most cost-effective treatment
- Where to apply the treatment
- When is the best time to apply the treatment

The need for a large city based PMS is becoming more of a necessity as local agencies struggle to keep up with the growing demand of rehabilitating the roadway infrastructure in their jurisdiction. The PMS system must be specialized to meet the governing agencies needs. It is with this in mind that this study was conducted.

In this paper fifteen states owned and maintained corridors within the city of Baton Rouge, LA were evaluated to determine the effectiveness of the proposed PMS. Correlations between the collected pavement condition and the LADOTD condition were formed and discussed.

The purpose of this study was to provide the local governing agency, the City of Baton Rouge, LA, with the foundation necessary for forming their PMS. Because of the lack of historical data at the beginning of the PMS life, it is imperative that the city use the LADOTD pavement family curves, distress triggers, maintenance strategies, and prioritization methods until enough data is gathered to formulate these parameters privately.

IV. REFERENCES

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